Measurement and Test Requirements

Unless otherwise agreed, the Government and the Contractor shall supply equipment and conform to procedures that are in accordance with the latest version of the standards referred to in this document.

Devices

A. Government-supplied Devices: The Government shall supply, operate and maintain, or cause to be supplied, operated and maintained, devices required for collecting samples and for determining quality and composition of the LNG and any other measurement or testing devices which are necessary to perform the measurement and testing required hereunder at the NSGB Facility.

B. Contractor-supplied Devices: The Contractor or the Contractor's agent shall supply, operate and maintain, or cause to be supplied, operated and maintained, suitable gauging devices for the liquid level in LNG tanks of the LNG Tankers, pressure and temperature measuring devices, and any other measurement or testing devices which are incorporated in the structure of LNG vessels or customarily maintained on board ship.

C. Selection of Devices: The required degree of accuracy (which shall in any case be within the permissible tolerances defined herein and in the applicable standards referenced herein) of such devices selected shall be mutually agreed upon by the Government and the Contractor. In advance of the use of any device, the Party providing such device shall cause tests to be carried out to verify that such device has the required degree of accuracy.

Verification of Accuracy and Correction for Error

A. Accuracy. Accuracy of devices used shall be tested and verified at the request of either Party, including the request by a Party to verify accuracy of its own devices. The Government shall have the right to inspect at any time the measurement devices installed by the Contractor, provided that the Contractor is notified in advance. Testing shall be performed only when both Parties are represented, or have received adequate advance notice thereof, using methods recommended by the manufacturer or any other method agreed to by the Contractor and the Government. Permissible tolerances shall be as defined herein or as defined in the applicable standards referenced herein.

B. Inaccuracy. Inaccuracy of a device exceeding the permissible tolerances shall require correction of previous recordings, and computations made on the basis of those recordings, to zero error with respect to any period which is definitely known or agreed upon by the Parties as well as adjustment of the device. All invoices issued during such period shall be amended accordingly to reflect such correction, and an adjustment in payment shall be made between the Government and the Contractor. If the period of error is neither known nor agreed upon, and there is no evidence as to the duration of such period of error, corrections shall be made and invoices amended for each delivery of LNG made during the last half of the period since the date of the most recent calibration of the inaccurate device.

C. Costs and Expenses of Test Verification. All costs and expenses for testing and verifying the Contractor's measurement devices shall be borne by the Contractor, and all costs and expenses for testing and verifying the Government's measurement devices shall be borne by the Government.

Tank Gauge Tables of LNG Tankers

A. Initial Calibration. The Contractor shall arrange or caused to be arranged, for each tank of each LNG Tanker, a calibration of volume against tank level. The Contractor shall provide the Government or its designee, or cause the Government or its designee to be provided, with a certified copy of tank gauge tables for each tank of each LNG Tanker verified by a competent impartial authority or authorities mutually agreed upon by the Parties. Such tables shall include correction tables for list, trim, tank contraction and any other items requiring such tables for accuracy of gauging.

Tank gauge tables prepared pursuant to the above shall indicate volumes in cubic meters expressed to the nearest thousandth (1/1000), with LNG tank depths expressed in meters to the nearest hundredth (1/100).

B. Presence of Representatives. The Contractor and the Government shall each have the right to have representatives present at the time each LNG tank on each LNG Tanker is volumetrically calibrated.

C. Recalibration. If the LNG tanks of any LNG Tanker suffer distortion of such nature as to create a reasonable doubt regarding the validity of the tank gauge tables described herein (or any subsequent calibration provided for herein), the Contractor or the Contractor’s agent shall recalibrate the damaged tanks, and the vessel shall not be employed as an LNG Tanker hereunder until appropriate corrections are made. If mutually agreed between the Government and the Contractor representatives, recalibration of damaged tanks can be deferred until the next time when such damaged tanks are warmed for any reason, and any corrections to the prior tank gauge tables will be made from the time the distortion occurred. If the time of the distortion cannot be ascertained, the Parties shall mutually agree on the time period for retrospective adjustments.

D. Units of Measurement and Calibration

The Parties shall co-operate in the design, selection and acquisition of devices to be used for measurements and tests in order that all measurements and tests may be conducted in the SI system of units, except for the quantity delivered which is expressed in MMBtu, the Gross Heating Value (volume based) which is expressed in Btu/SCF and the pressure which is expressed in millibar and temperature in Celsius. In the event that it becomes necessary to make measurements and tests using a new system of units of measurements, the Parties shall establish agreed upon conversion tables.

E. Accuracy of Measurement

All measuring equipment must be maintained, calibrated and tested in accordance with the manufacturer's recommendations. In the absence of a manufacturer's recommendation the minimum frequency of calibration shall be one hundred eighty (180) days, unless otherwise mutually agreed between the Parties. Documentation of all tests and calibrations will be made available by the Party performing the same to the other Party. Acceptable accuracy and performance tolerances shall be:

F. Liquid Level Gauging Devices. Each LNG tank of the LNG Tanker shall be equipped with primary and secondary liquid level gauging devices. The measurement accuracy of the primary gauging devices shall be plus or minus seven point five (± 7.5) millimeters and the secondary liquid level gauging devices shall be plus or minus ten (± 10) millimeters. The liquid level in each LNG tank shall be logged or printed.

G. Temperature Gauging Devices. The temperature of the LNG and of the vapor space in each LNG tank shall be measured by means of a number of properly located temperature measuring devices sufficient to permit the determination of average temperature.

1. The measurement accuracy of the temperature gauging devices shall be as follows:

   a. in the temperature range of minus one hundred sixty five to minus one hundred forty degree Celsius (-165C to -140°C), the accuracy shall be plus or minus zero point two degree Celsius (± 0.2 ° C);

   b. in the temperature range of minus one hundred forty to plus forty degree Celsius (-140C to +40 ° C), the accuracy shall be plus or minus one point five degree Celsius (± 1.5 °C).

   c. The temperature in each LNG tank shall be logged or printed.

H. Pressure Gauging Devices. Each LNG tank of the LNG Tanker shall have one (1) absolute pressure gauging device. The measurement accuracy of the pressure gauging device shall be plus or minus one percent (± 1%) of the measuring range. The pressure in each LNG tank shall be logged or printed.

I. List and Trim Gauging Devices. A list gauging device and a trim gauging device shall be installed. These shall be interfaced with the custody transfer system. The measurement accuracy of the list and the trim gauging devices shall be better than plus or minus zero point zero five (±0.05) degrees for list and plus or minus zero point zero one (± 0.01) degrees for trim.

J. Gauging and Measuring LNG Volumes Delivered

1. Gauge Tables. Upon the Government's representative and the independent surveyor, if present, arriving on board the LNG Tanker prior to the commencement of or during

unloading, the Contractor or the Contractor's representative shall make available to them a certified copy of tank gauge tables for each tank of the LNG Tanker.

2. **Gauges.** Volumes of LNG delivered pursuant to this Agreement shall be determined by gauging the LNG in the tanks of the LNG Tankers before and after unloading. Each LNG Tanker's tank shall be equipped with a minimum of two (2) independent sets of level gauges, each set utilizing preferably a different measurement principle. Comparison of the two (2) systems, designated as Primary and Secondary Measurement Systems, shall be performed from time to time to ensure compliance with the acceptable performance tolerances stated herein.

3. **Gauging Process.** Gauging the liquid in the tanks of the LNG Tankers and measuring of liquid temperature, vapor temperature and vapor pressure in each LNG tank, trim and list of the LNG Tankers, and atmospheric pressure shall be performed, or caused to be performed, by the Contractor before and after loading. The Government shall have the right to be present while all measurements are performed and shall verify the accuracy and acceptability of all such measurements. The first gauging and measurements shall be made immediately before the commencement of unloading. The second gauging and measurements shall take place immediately after the completion of unloading.

4. **Records.** Copies of gauging and measurement records shall be furnished to the Contractor immediately upon completion of unloading.

5. **Gauging Liquid Level of LNG.** The level of the LNG in each LNG tank of the LNG Tanker shall be gauged by means of the primary gauging device installed in the LNG Tanker for that purpose. The level of the LNG in each tank shall be logged or printed. Measurement of the liquid level in each LNG tank of the LNG Tanker shall be made to the nearest millimeter by using the primary liquid level gauging devices. Should the primary devices fail, the secondary device shall be used. Five (5) readings shall be made following manufacturer's recommendations on reading interval. The arithmetic average of the readings rounded to the nearest millimeter using one (1) decimal place shall be deemed the liquid level.

6. **Determination of Temperature.** The temperature of the LNG and of the vapor space in each LNG tank shall be measured by means of a sufficient number of properly located temperature measuring devices to permit the determination of average temperature. Temperatures shall be measured at the same time as the liquid level measurements and shall be logged or printed.

    a. In order to determine the temperature of liquid and vapor respectively in the LNG Tanker one (1) reading shall be taken at each temperature gauging device in each LNG tank. An arithmetic average of such readings rounded to the nearest zero point one degree Celsius (0.1 °C) using two (2) decimal places with respect to vapor and liquid in all LNG tanks shall be deemed the final temperature of the vapor and liquid respectively.

b. The Contractor shall cause each cargo tank in the LNG Tanker to be provided with a minimum of five (5) temperature measuring devices. One such measuring device shall be located in the vapor space at the top of each cargo tank, one near the bottom of each cargo tank and the remainder distributed at appropriate intervals from the top to the bottom of the cargo tank. These devices shall be used to determine the average temperatures of the liquid cargo and the vapor in the cargo tank.

c. The average temperature of the vapor in an LNG Tanker shall be determined immediately before unloading by means of the temperature measuring devices specified above at the same time as when the liquid level is measured. The temperature measuring devices shall be fully surrounded by the vapor. This determination shall be made by taking the temperature readings of the temperature measuring devices in question to the nearest zero point zero one degrees Celsius (0.01°C), and if more than one of the devices are fully surrounded by the vapor, by averaging those readings, and rounding to one (1) decimal place.

d. The average temperature of the liquid in an LNG Tanker shall be determined immediately after unloading by means of the temperature measuring devices specified above.

7. **Determination of Pressure.** The pressure of the vapor in each LNG tank shall be determined by means of pressure measuring devices installed in each LNG tank of the LNG Tankers. The atmospheric pressure shall be determined by readings from the standard barometer installed in the LNG Tankers. Pressures shall be measured at the same time as the liquid level measurements, and shall be logged or printed.

    a. The Government shall cause the LNG Tanker to be provided with pressure measuring equipment capable of determining the absolute pressure of the vapor in each cargo tank with an accuracy equal to or better than plus or minus one percent (± 1%) of the measuring range.

    b. The pressure of the vapor in an LNG Tanker shall be determined immediately before unloading at the same time as when the liquid level is measured.

    c. Such determination shall be made by taking the pressure readings of the pressure measuring devices to the nearest millibar, then averaging these readings and rounding to a whole millibar.

8. **Determination of Density.** The LNG density shall be calculated using the revised Klosek- McKinley method. Should any improved data, method of calculation or direct measurement device become available which is acceptable to both the Government and the Contractor, such improved data, method or device shall then be used.

Quality Analysis Representative liquid samples shall be collected from an appropriate point located as close as practical to the unloading line starting one (1) hour after full unloading rate is reached and ending one (1) hour before ramping down from the full unloading rate. A sample

shall be taken and analyzed at least once every twenty (20) minutes by an on-line chromatograph during this period. Samples taken when biphasic or overheated LNG is suspected to be in the main transfer line will be disregarded. These incremental samples will be passed through a vaporizer, and samples of the vaporized liquid will be analyzed. The resulting analyses, which are generally proportional to time, will be arithmetically averaged to yield an analysis that is representative of the unloaded LNG cargo. This arithmetically averaged analysis shall be used for all appropriate calculations associated with the delivered LNG cargo. If both the Contractor and the Government agree that the result of the arithmetic average does not give a fair representation of the composition of the LNG, both Parties shall meet and decide in good faith the appropriate method to determine the composition of the LNG. Should the automatic sampling system fail during the unloading, manual samples shall be collected and analyzed for accounting purposes.

A. Manual Samples. Prior to the end of the unloading cycle, three (3) sets of spot samples shall be collected from the vaporizer at the following intervals during unloading, when unloading is twenty-five percent (25%), fifty percent (50%), and seventy-five percent (75%) complete. Spot samples shall be collected in accordance with Gas Processors Association ("GPA") Standard 2166 - Methods for Obtaining Gas Samples for Analysis by Gas Chromatography - or by other mutually agreeable methods. The samples shall be properly labeled and then distributed to the Government and the Contractor. The Contractor shall retain one (1) sample for a period of thirty (30) days, unless the analysis is in dispute. If the analysis is in dispute, the sample will be retained until the dispute is resolved. Sampling and analysis methods and procedures that differ from the above may be employed with the mutual agreement of the Parties.

B. Certification and Deviation. Chromatograph calibration gasses shall be provided and their composition certified by an independent third party. From time to time, deviation checks shall be performed to verify the accuracy of the gas composition mole percentages and resulting calculated physical properties. Analyses of a sample of test gas of known composition resulting when procedures that are in accordance with the above mentioned standards have been applied will be considered as acceptable if the resulting calculated gross heating value is within plus or minus zero point three percent (± 0. 3%) of the known gross heating value of the test gas sample. If the deviation exceeds the tolerance stated, the gross real heating value, relative density and compressibility previously calculated will be corrected immediately. Previous analyses will be corrected to the point where the error occurred, if this can be positively identified to the satisfaction of both Parties. Otherwise it shall be assumed that the drift has been linear since the last recalibration and correction shall be based on this assumption.

1. **GPA Standard 2261.** All samples shall be analyzed by the Government to determine the molar fraction of the hydrocarbon and other components in the sample by gas chromatography using a mutually agreed method in accordance with GPA Standard 2261 - Method of Analysis for Gas and Similar Gaseous Mixtures by Gas Chromatography, current as of January 1, 1990 and as periodically updated or as otherwise mutually agreed by the Parties. If better standards for analysis are subsequently adopted by GPA or other recognized competent impartial authority, upon mutual agreement of the Government and

the Contractor, they shall be substituted for the standard then in use, but such substitution shall not take place retroactively. A calibration of the chromatograph or other analytical instrument used shall be performed by the Government immediately prior to the analysis of the sample of LNG delivered. The Government shall give advance notice to the Contractor of the time the Government intends to conduct a calibration thereof, and the Contractor shall have the right to have a representative present at each such calibration; provided, however, the Government will not be obligated to defer or reschedule any calibration in order to permit the representative of the Contractor to be present.

2. **GPA Standard 2377 and 2265.** The Government shall determine the presence of Hydrogen Sulfide (H2S) by use of GPA Standard 2377 - Test of Hydrogen Sulfide and Carbon Dioxide in Gas Using Length of Stain Tubes. If necessary, the concentration of H2S and total sulfur will be determined using one or more of the following methods as is appropriate: gas chromatography, Gas Processors Standard 2265 Standard for Determination of Hydrogen Sulfide and Mercaptan Sulfur in Gas (Cadmium Sulfate - Iodometric Titration Method) or any other method that is mutually acceptable. If Hydrogen Sulfide or Carbon Dioxide are detected by the above methods then the Government shall confirm the presence of Hydrogen Sulfide or Carbon Dioxide in accordance with GPA Standard 2261-00 (Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography).

C. Operating Procedures. Prior to conducting operations for measurement, gauging, sampling and analysis, the Party responsible for such operations shall notify the appropriate representatives of the other Party, allowing such representatives reasonable opportunity to be present for all operations and computations; provided that the absence of the other Party's representative after notification and opportunity to attend shall not prevent any operations and computations from being performed.

D. Independent Surveyor. At the request of either Party any measurement, gauging, sampling and analysis shall be witnessed and verified by an independent surveyor mutually agreed upon by the Government and the Contractor. The results of such surveyor's verifications shall be made available promptly to each Party.

E. Preservation of Records. All records of measurement and the computed results shall be preserved by the Party responsible for taking the same, or causing the same to be taken, and made available to the other Party for a period of not less than three (3) years after such measurement and computation.